Original Article

Dietary and exercise interventions for metabolic health in perimenopausal women in Beijing

Shuping Hao MM[1], Sisi Tan MM[2], Jing Li MD[1], Weimin Li MM[1], Jingyun Li MM[1], Xiaochen Cai MM[1], Zhongxin Hong MM[2]

[1]*Department of Clinical Nutrition, Pinggu Hospital, Beijing Friendship Hospital, affiliated to Capital Medical University, Beijing, China*
[2]*Department of Clinical Nutrition, Beijing Friendship Hospital, Capital Medical University, Beijing, China*

Background and Objectives: This study aims to investigate the effects of individualised dietary guidance and anti-resistance exercise intervention on blood pressure and metabolic indexes of perimenopausal women. **Methods and Study Design:** Between June 2018 to August 2018, 78 perimenopausal women were recruited at the Gynaecological Outpatient Department of Beijing Pinggu District Hospital. After coding, they were randomly divided into three groups, A, B and C, by lottery. Group A was required to participate in educational seminars. Group B was required to participate in educational seminars and received individualised dietary guidance from professional nutritionists. Group C had the same intensive education classes and individualised dietary guidance as Group B, along with intensive resistance exercise. The difference in the various observation indexes was reviewed after three months of intervention. **Results:** The number of patients with abnormal metabolic indexes in the diet and comprehensive groups decreased significantly after intervention, compared with the statistics before intervention. The number of patients with a waist circumference ≥80 cm in the diet and comprehensive groups decreased significantly, and the difference was statistically significant (χ^2=5.976, *p*=0.014; χ^2=4.433, *p*=0.035). Before and after observation, the control and diet groups had a higher incidence of HDL <1.29 mmol/L than the comprehensive group, and the difference was statistically significant (p<0.05). After intervention, TGs in the comprehensive group were significantly lower than the control group (≥1.7 mmol/L), and the difference was statistically significant. **Conclusions:** Individualised dietary intervention combined with anti-resistance exercise can significantly improve eating and exercise habits, correct metabolic disorders and reduce the occurrence of metabolic syndrome.

Key Words: perimenopausal period, metabolic syndrome, dietary interventions, resistance movement, perimenopausal women

INTRODUCTION

The perimenopausal period is a woman's transition from regular menstruation during the reproductive years to menopause, lasting up to one year after the last menstruation cycle, and includes changes in endocrine, biological and clinical characteristics related to the decline of ovarian function.[1] During this period, a woman's ovarian function and oestrogen levels will decline in varying degrees, resulting in a persistent deficiency.[2] The effect of oestrogen deficiency is systemic, as oestrogen receptors are found in almost all organs of the body. Perimenopausal women have a significantly increased risk of hyperlipidaemia and related chronic diseases due to decreases in their basal metabolic rate and increases in body mass and fat. Therefore, perimenopausal women are at high risk for metabolic syndrome.[3] This study aims to research routine health education and individualised diet intervention combined with resistance exercise training to observe the impact of different intervention methods on the relevant metabolic indicators of perimenopausal women in this region and provide the basis for further standardising the health management of the population at this stage.

METHODS

Ethics approval and consent to participate

This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Beijing Friendship Hospital. Written informed consent was obtained from all participants.

Ethics Approval NO.:2018-QWK001-01

Research subjects

From June 2018 to August 2018, 78 perimenopausal women at the gynaecological clinic of Beijing Pinggu District Hospital were selected, with an average age of

Corresponding Author: Dr Zhongxin Hong, Department of Clinical Nutrition, Beijing Friendship Hospital, Capital Medical University, No.95 Yongan Road, Xicheng District, Beijing, Beijing 100050, China.
Tel: +8610 63138268; Fax: +86 10 63023261
Email: hzx222@yeah.net
Manuscript received 26 July 2021. Initial review and accepted 08 September 2021.
doi: 10.6133/apjcn.202112_30(4).0009

48.7±3.06 years. According to the treatment method, they were divided into three groups: the control group, diet group and comprehensive group. There were 18 cases in the control group, and they received regular health education. The diet group, with 28 cases, was given individualised diet guidance. The comprehensive group, with 32 cases, was given diet guidance combined with resistance exercise. The Ethics Committee of our hospital has reviewed this study, and all subjects gave informed consent.

Random grouping steps: the subjects were divided into average weight and overweight groups according to their body mass index (BMI). Then, the subjects in the two groups were numbered independently and randomly divided into the control, diet and comprehensive groups (Figure 1).

Inclusion and exclusion criteria

Inclusion criteria: (1) females with a clear perimenopausal diagnosis; (2) having received no systematic nutrition education; (3) able to walk without help. Exclusion criteria: (1) patients having chewing, swallowing or digestion dysfunctions, and are unable to eat natural food normally; (2) having taken weight-loss drugs for weight loss treatment within three months; (3) chronic renal insufficiency and renal failure; (4) diabetic patients treated with insulin; (5) upper or lower limb fractures and other exercise contraindications in the past three months; (6) suffering from neuromuscular disease or taking drugs that affect neuromuscular function; (7) suffering from myocardial infarction, unstable cardiovascular disease or other diseases in the past three months.

Research methods

The control group received a routine gynaecological diagnosis and treatment and participated in education courses taught by nutritionists, pharmacists and nurses on the importance of menopausal nutrition and metabolism. These patients also learned the significance and fundamentals of dietary intervention, exercise methods and precautions, drug selection and proper ways of taking medications, with a monthly telephone follow-up.

The diet group was required to participate in all centralised education courses, and individualised diet guidance was carried out according to the (Dietary Approaches to Stop Hypertension) DASH diet principle.[4] They filled out a diet diary three days a week and uploaded it

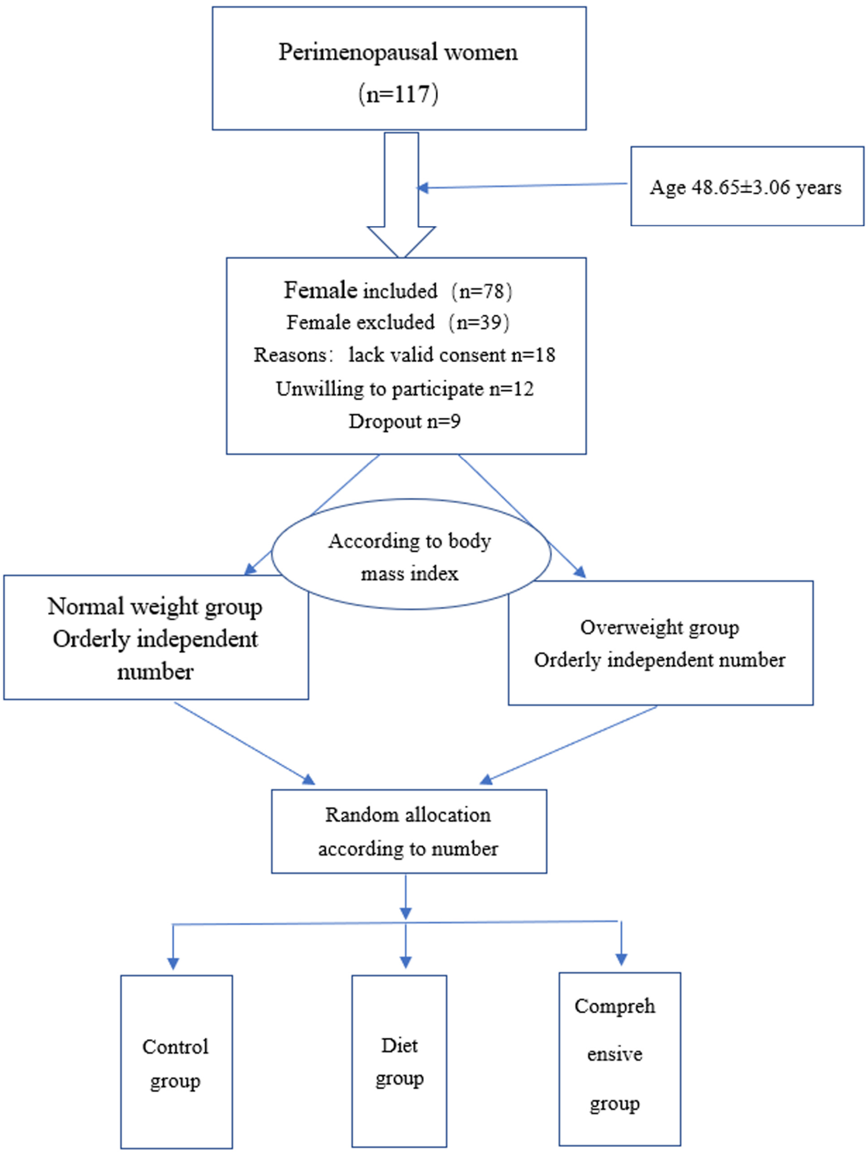

Figure 1. Study flow diagram.

via WeChat. Any deviation in diet structure was corrected. One face-to-face follow-up was conducted each month, and the individualised diet plan was dynamically adjusted to provide a meal demonstration.

The comprehensive group had routine health education, individualised diet intervention and resistance exercise training by professional sports coaches with on-site guidance twice a week, which focused on resistance exercise for 30 minutes each time. They participated in aerobic exercise more than two days a week, walking or jogging 6,000–10,000 steps a day, and uploaded the records via WeChat. After three months of intervention, the changes in observation indexes were reviewed.

The centralised education plan was unified by participation in the centralised teaching by nutritionists, pharmacists and nurses. The lessons included menopause nutrition and metabolism, the significance of dietary intervention and DASH dietary principles, the significance, methods and precautions of exercise, and the selection, timing and methods of taking perimenopausal oestrogen drugs.

Individualised guidance: the observers were assigned groups and added to the WeChat group. Professional clinical nutritionists continued to follow up and manage the patients. The daily energy and nutrient requirements were determined according to the patients' height, weight and activity levels, and past habits and working characteristics were examined in detail. Individualised dietary guidance was provided, and meal times were arranged. According to the DASH diet principles, the seven food groups allowed include fruit, vegetables, nuts, beans, low-fat dairy products, whole grains and white meat. The restricted foods include salt, sweet drinks, red meat, processed meat, fatty meat and animal viscera. The patients' recorded in their diet diaries three days a week, with a timely upload on WeChat, and any deviation in diet structure was corrected. The patients completed a monthly face-to-face follow-up that provided samples of a model diet and experience with food preparation, tasting and concepts to strengthen a proper diet. The actual plan was designed as follows: The subjects of the diet group and the exercise group were asked to have two face-to-face follow-up one month and two months after the observation. Referring to the food quantitative model, the implementation of the diet plan was investigated, and a nutritional demonstration meal was provided at noon on the day of follow-up.

Observation indicators

General information

A total of 78 questionnaires were distributed, and all were returned. The survey contents included age, education level, waist circumference, height, weight, fertility, menopause, exercise, etc., and past medical history, including hypertension, diabetes and hyperlipidaemia, liver and kidney diseases, etc.

Laboratory index test

The nutrition and metabolism tests with related items and body measurements were completed within one week. The patients started fasting at 10 p.m. the day before blood collection, and 5 ML of venous blood was drawn on an empty stomach before 10 a.m. the next day. The research group used a standard test method to test triglycerides (TG) using the GOP-POP method, high-density lipoprotein cholesterol (HDL-C) using the direct method-catalase removal method, and fasting blood glucose using the immunoturbidimetric method.

Diagnostic criteria for metabolic syndrome

The 2015 version of the International Diabetes Federation (IDF) new global standard for MS5 was adopted: (1) central obesity (Chinese women with abdominal circumference ≥80 cm); (2) meeting any two of the following four items, triacylglycerol ≥150 mg/dL (1.7 mmol/L), or have received appropriate treatment; systolic blood pressure ≥130 mmHg (1 mmHg = 0.133 kPa) or diastolic blood pressure ≥85 mmHg, or have received hypertension-related treatment; high-density lipoprotein cholesterol <50 mg/DL (1.29 mmol/L), or have received appropriate treatment; rapid intravenous fasting blood glucose ≥100 mg/DL (5.6 mmol/L), or previously diagnosed with type 2 diabetes. In this paper, those who met the above criteria were considered to have abnormal metabolic indicators.

Normal metabolism: (1) abdominal circumference <80 cm, triacylglycerol <150 mg/dL (1.7 mmol/L) and not taking any lipid-lowering drugs; (2) systolic blood pressure <130 mmHg and diastolic blood pressure <85 mmHg, and not taking any antihypertensive drugs; (3) high-density lipoprotein cholesterol >50 mg/dL (1.29 mmol/L) and not taking any relevant treatment measures; (4) rapid intravenous blood glucose 100 mg (5.6 mmol/L), with no history of type 2 diabetes.

Diagnostic criteria for being overweight or obese

In accordance with the WS/T428-2013 Chinese adult weight judgment standard: normal weight is 18.5–23.99 kg/m^2, overweight 24–27.99 kg/m^2 and obese is greater than or equal to 28 kg/m^2. According to the 'Guidelines for the Prevention and Control of Overweight and Obesity in Adults in China' published by the Department of Disease Control of the National Health and Family Planning Commission in 2003, BMI <18.5 kg/m^2 is considered too thin, 18.5 kg/m2 ≤BMI ≤23.9 kg/m^2 is considered normal, 24.0 ≤BMI ≤27.9 kg/m^2 is considered overweight, and BMI ≥28.0 kg/m^2 is considered obese. Female waist circumference ≥80 cm is considered central obese.[6]

Statistical methods

SPSS 17.0 statistical analysis software was used to process the data. All measurement data were expressed as mean ± standard deviation ($\bar{X}$±s). An ANOVA test was used to compare the measurement data between groups, and a paired t-test was used to compare the measurement data before and after intervention. The chi-square test compared counting data. $p<0.05$ indicated that the difference was statistically significant.

RESULTS

Comparison of general data

There was no statistical difference in age, BMI, educational background, occupational data or drug use before and after intervention in the three groups ($p>0.05$) (Tables 1 and 2).

Table 1. Comparison of general data of 78 patients

Group	Number of cases	Age	BMI	Education (Below junior college/bachelor degree or above)	Occupation (Medical/non-medical)
Control group	18	49.17±3.22	25.13±3.18	9/19	4/14
Diet group	28	48.93±3.04	25.28±3.61	12/16	11/17
Comprehensive group	32	48.13±3.00	24.45±3.17	18/14	14/18
F/χ^2		0.839	0.516	1.071†	2.369†
p		0.436	0.599	0.585	0.306

†χ^2 value.

Table 2. Comparison of medications in different groups

Survey topic	Lipid-lowering drugs		Antihypertensive drugs		Antidiabetic drugs		Sex hormones	
	Before observation (Yes/No)	After observation (Yes/No)	Before observation (Yes/No)	After observation (Yes/No)	Before observation (Yes/No)	After observation (Yes/No)	Before observation (Yes/No)	After observation (Yes/No)
Control group	3/15	0/18	3/15	4/14	1/17	1/17	1/17	2/16
Diet group	1/27	1/27	6/22	6/22	0/28	0/28	2/26	3/25
Comprehensive group	2/30	0/32	2/30	2/30	1/31	1/31	3/29	3/29
χ^2	2.494	2.072	3.185	3.846	1.978	1.978	0.259	0.048
p	0.287	0.355	0.203	0.146	0.372	0.372	0.878	0.976

Changes in blood pressure after different interventions

In the control group, there were two cases with diastolic blood pressure ≥85 mmHg before observation and four cases after observation, an increase of two cases. There were six cases with systolic blood pressure ≥130 mmHg before the observation, and five cases after observation, with a decrease of one case. There was no statistically significant difference in systolic blood pressure before and after intervention (p>0.05). In the diet group, there were 10 cases with systolic blood pressure ≥130 mmHg before observation, and six cases after observation, decreasing by four cases. There were seven cases with diastolic blood pressure ≥85 mmHg before observation, and there was no change in the number of cases after observation. After intervention, systolic blood pressure decreased by 16.5±13.91 mmHg, diastolic blood pressure decreased by 9.57±6.73 mmHg, and the difference was statistically significant (p<0.05). In the comprehensive group, there were eight cases with systolic blood pressure ≥130 mmHg before observation, and two cases after observation, decreasing by six cases. There were six cases with diastolic blood pressure ≥85 mmHg before observation, and two cases after observation, decreasing by four cases. The difference in systolic blood pressure before and after intervention was 11.88±14.91 mmHg, and the difference in diastolic blood pressure was 4.67±6.22 mmHg. There was no significant difference in diastolic and systolic blood pressures before and after observation (p>0.05) (Table 3).

Changes in metabolic indicators

Based on the 2015 IDF diagnostic criteria for metabolic syndrome, abnormal fasting blood glucose and TG cases increased after intervention in the control group, and the number of cases with waist circumference ≥80 cm decreased by four cases. There was no change in the number of cases with metabolic syndrome and HDL <1.29 mmol/L. After the intervention, the abnormal waist circumference and metabolic indexes were decreased in the diet and comprehensive groups. The number of cases with waist circumference ≥80 cm in the diet and comprehensive groups decreased significantly after intervention, and the difference was statistically significant (diet group χ^2=5.976, p=0.014; comprehensive group χ^2=4.433, p=0.035). Before and after the observation, HDL <1.29 mmol/l in the control and diet groups was higher than in the comprehensive group, and the difference was statistically significant (p<0.05). After the intervention, the number of cases with TG ≥1.7 mmol/L in the comprehensive group was significantly lower than the control group, and the difference was statistically significant (Table 4).

DISCUSSION

Most studies conducted worldwide indicate that the perimenopausal period has the greatest adverse effects on women's quality of life.[7] This study analysed the impact of diet and exercise intervention on blood pressure and metabolism-related indicators in perimenopausal women.

The results showed that the diet group had 10 cases with systolic blood pressure ≥130 mmHg before observation and four cases after observation, but there was no change in the diastolic blood pressure ≥85 mmHg before and after observation. After intervention, the systolic blood pressure level decreased by 16.5±13.91 mmHg, and the diastolic blood pressure decreased by 9.57±6.73 mmHg, and the difference was statistically significant (p<0.05). In the comprehensive group, there were eight cases with systolic blood pressure ≥130 mmHg before observation, and after, there was a decrease of six cases. There were six cases with diastolic blood pressure ≥85 mmHg before observation, and after, there was a decrease of four cases. The difference in systolic blood pressure before and after the intervention was 11.88±14.91 mmHg, and the difference in diastolic blood pressure was 4.67±6.22 mmHg. Studies have shown that the incidence of coronary atherosclerotic heart disease (coronary heart disease) in women will increase due to the decline in oestrogen levels after menopause.[8] Effective diet and exercise intervention can effectively reduce the patient's blood pressure and blood lipid indicators to improve the patient's physical function. In a study by Zhou Huimin et al[9] dietary control combined with aerobic exercise improved the blood and physical indicators of obese patients, suggesting that diet and exercise play a positive role in weight loss, which can help obese patients prevent fatty liver and coronary heart disease and atherosclerosis, improving their health.[10-11]

The DASH diet can reduce blood pressure,[12] which is comparable to the antihypertensive effect of drugs. Exercise can also effectively reduce blood pressure. In this study, the comprehensive diet combined with exercise intervention had a significant impact on blood pressure. A low salt diet with whole grain and fruit intake is beneficial to the improvement of blood pressure. Dyslipidaemia is related to a poor diet regimen, excessive fat and high carbohydrate intake.[13] The DASH diet emphasises low-fat milk, whole grains, fish, poultry and other white meat and limits processed and red meat intake. Perimenopausal women are affected by hormone levels, and oestrogen levels are reduced. Lipid metabolism is abnormal in terms of low-density lipoprotein, high cholesterol and triglycerides. Appropriate exercise is beneficial for energy consumption, improving body metabolism and reducing fat accumulation. Fasting blood glucose was correlated with insulin resistance. Insulin resistance was correlated with BMI, abdominal fat accumulation and hormone levels. This study showed that the abnormal fasting blood glucose in the control group increased after three months of observation, and the abnormal fasting blood glucose in the diet and intervention groups decreased. Factors in AHA life include core health behaviours (smoking, physical activity, diet, weight) and health factors that contribute to cardiovascular health (cholesterol, blood pressure, blood glucose control).[14]

In this study, the number of patients with abnormal waist circumference and metabolic indexes in the diet and comprehensive groups was reduced after intervention. The number of patients with a waist circumference ≥80 cm in the diet and comprehensive groups was significantly reduced. After intervention, TG ≥1.7 mmol/L in the comprehensive group was significantly lower than in the control group, and the difference was statistically significant. It is suggested that diet combined with exercise can effectively regulate blood lipid indexes and reduce pa-

Table 3. Comparison of changes in blood pressure before and after observation of different intervention methods

Group	Number of cases	Systolic blood pressure ≥130mmHg			95% confidence interval of difference			
		Before intervention n (%)	After intervention n (%)	Difference	Lower limit	Upper limit	t	*p*
Control group	18	6 (33.3)	5 (27.8)	-1.83±9.35	-11.64	7.98	-0.480	0.651
Diet group	28	10 (35.7)	6 (21.4)	16.5±13.91	6.55	26.45	3.752	0.005
Comprehensive group	32	8 (25)	2 (6.3)	11.88±14.91	-0.59	24.34	2.252	0.059
Total	78	24 (30.8)	13 (16.7)	10.38±14.78	4.14	16.61	3.44	0.002
X^2		0.877	4.791					
p		0.645	0.084					

Group	Diastolic blood pressure ≥85mmHg			95% confidence interval of difference			
	Before intervention n (%)	After intervention n (%)	Difference	Lower limit	Upper limit	t	*p*
Control group	2 (11.1)	4 (22.2)	-	-	-	-	-
Diet group	7 (25)	7 (25)	9.57±6.73	3.35	15.8	3.763	0.009
Comprehensive group	6 (18.7)	2 (6.3)	4.67±6.22	-1.86	11.19	1.838	0.125
Total	15 (19.2)	13 (16.7)	6.67±6.52	3.05	10.28	3.959	0.001
X^2	1.369	4.188					
p	0.504	0.126					

Table 4. Comparison of changes in laboratory indicators before and after observation of different intervention methods (n)

Group	Number of cases	Fasting blood glucose ≥5.6 mmol/L		HDL <1.29 mmol/L		TG ≥1.7 mmol/L		Waist circumference ≥80 cm		Metabolic syndrome	
		Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Control group	18	2	3	14	14	6	10	11	7	8	8
Diet group	28	5	3	19	18	9	8	16	7[†]	12	7
Comprehensive group	32	7	5	14[§]	13[¶]	10	8[¶]	15	7[‡]	11	6
Total	78	14	11	47	45	25	26	42	21	31	21

[†]The diet group compared with before intervention, $p<0.05$.
[‡]The comprehensive group compared with before intervention, $p<0.05$.
[§]The comprehensive group compared with the control group before intervention, $p<0.05$.
[¶]The comprehensive group compared with the control group after intervention, $p<0.05$.

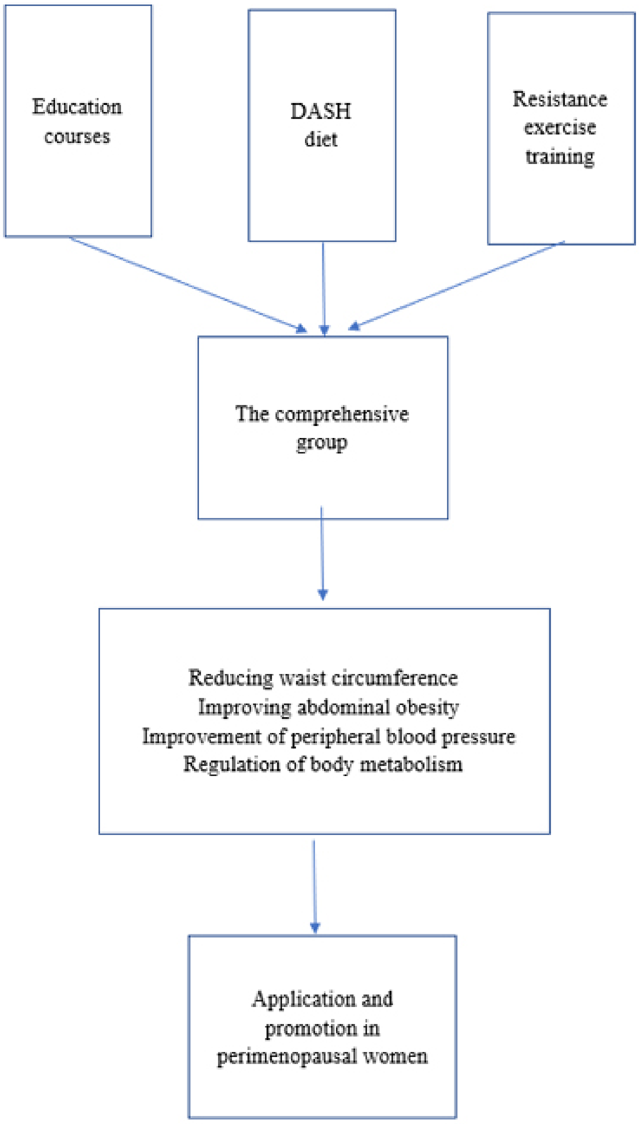

Figure 2. Effect of the comprehensive measures.

tients' body mass. Reasonable exercise can increase the secretion of oestrogen in perimenopausal women and reduce the levels of cholesterol, triglycerides and low-density lipoprotein.[15]

In summary, strengthening diet and exercise for individualised management in perimenopause can significantly improve blood pressure and regulate blood lipids, thereby alleviating perimenopausal symptoms and reducing the occurrence of chronic diseases. It is worthy of clinical promotion (Figure 2).

AUTHOR DISCLOSURES

All of the authors had no any personal, financial, commercial, or academic conflicts of interest separately.

REFERENCES

1. Jia FF, Wang JL. Exploring the social psychological factors of mental disorders in perimenopausal patients. Psychological Monthly. 2021;16:13-4. doi: 10.19738/j.cnki.psy.2021.08.007.
2. Ren XQ. Analysis of the influence of lifestyle intervention on the risk factors of cardiovascular disease in perimenopausal women. Journal of Practical Gynecologic Endocrinology. 2019;6:69-70.
3. Sun JX, Xi SS, Chen X, Cheng XX, Lu SY, Zhu LP, Bai WP, Yan XY. Influencing Factors for Menopause Complicated With Metabolic Syndrome. Chinese General Practice. 2015;19:2286-9. doi: 10.3969/j.issn.1007-9572.2015.19.011. (In Chinese)
4. Soltani S, Hashemi R, Heshmat R, Motlagh AD, Esmaillzadeh A. Association of dietary approaches to stop hypertension eating style and risk of sarcopenia. Sci Rep. 2020;10:19339. doi: 10.1038/s41598-020-76452-0.
5. Zinman B. The International Diabetes Federation World Diabetes Congress 2015. Eur Endocrinol. 2015;11:66. doi: 10.17925/EE.2015.11.02.66.
6. China Working Group on Obesity. Guidelines for Prevention and Control of Overweight and Obesity in Chinese Adults. Acta Nutrimenta Sinica. 2004;26:1-4. doi: 10.3321/j.issn:0512-7955.2004.01.001. (In Chinese)
7. Hajj AE, Wardy N, Haidar S, Bourgi D, Haddad ME, Chammas DE, El Osta N, Khabbaz LR, Papazian T. Menopausal symptoms, physical activity level and quality of life of women living in the Mediterranean region. PLoS One. 2020;15:e0230515. doi: 10.1371/journal.pone.0230515.
8. Wang JJ, He RH, Wu L. The relationship between postmenopausal coronary heart disease and estrogen levels, endothelial function and blood lipids. Ningxia Medical Journal. 2014;36:13-5. (In Chinese)

9. Zhou HM, Xiang Z. Six-week aerobic exercise combined with diet control on the body shape and blood indicators of obese adolescents. Chinese Journal of Applied Physiology. 2017;33:166-8. doi:10.12047/j.cjap.5430.2017.042. (In Chinese)
10. Nimmo MA, Leggate M, Viana JL, King JA. The effect of physical activity on mediators of inflammation. Diabetes Obes Metab. 2013;15(Suppl 3):51-60. doi: 10.1111/dom.12156.
11. Hayashino Y, Jackson JL, Hirata T, Fukumori N, Nakamura F, Fukuhara S, Tsujii S, Ishii H. Effects of exercise on C-reactive protein, inflammatory cytokine and adipokine in patients with type 2 diabetes: a meta-analysis of randomized controlled trials. Metabolism. 2014;63:431-40. doi: 10.1016/j.metabol.2013.08.018.
12. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. N Engl J Med. 2001;344:3-10. doi: 10.1056/NEJM200101043440101.
13. Chiu S, Bergeron N, Williams PT, Bray GA, Sutherland B, Krauss RM. Comparison of the DASH (Dietary Approaches to Stop Hypertension) diet and a higher-fat DASH diet on blood pressure and lipids and lipoproteins: a randomized controlled trial. Am J Clin Nutr. 2016;103:341-7. doi: 10.3945/ajcn.115.123281.
14. Khairy P, Ionescu-Ittu R, Mackie AS, Abrahamowicz M, PiloteL, Marelli AJ. Changing mortality in congenital heart disease.J Am Coll Cardiol. 2010;56:1149-57. doi: 10.1016/j.jacc.2010.03.085.
15. Ruan XY, Yang Y. Diet and exercise management of perimenopausal women. Journal of Practical Obstetrics and Gynecology. 2020;36:661-3.